

Chemical evolution of the Galactic disk(s)

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Abstract. We highlight some results from our high-resolution spectroscopic elemental abundance survey of F and G dwarf stars in the solar neighbourhood.

1. Introduction

To investigate the chemical and kinematical properties of the Galactic disk, and the thick disk in particular, we have undertaken a spectroscopic survey of 703 kinematically selected F and G dwarf stars in the Solar neighbourhood. Based on high resolution ($R = 45\,000$ to $110\,000$) and high signal-to-noise ($S/N \approx 150$ to 300) spectra for all stars we determined detailed elemental abundances for O, Na, Mg, Al, Si, Ca, Ti, Cr, Fe, Ni, Zn, Y, Ba, and stellar ages from isochrones. Including the results for the first 102 stars of the sample presented in Bensby et al. (2003, 2005), our main findings include: (i) at a given metallicity, the thick disk abundance trends are more α -enhanced than those of the thin disk; (ii) the metal-rich limit of the thick disk reaches at least solar metallicities (Bensby et al. 2007b); (iii) the metal-poor limit of the thin disk is around $[\text{Fe}/\text{H}] \approx -0.8$; (iv) the thick disk shows an age-metallicity gradient; (v) the thin disk does *not* show an age-metallicity gradient; (vi) the most metal-rich thick disk stars at $[\text{Fe}/\text{H}] \approx 0$ are significantly older than the most metal-poor thin disk stars at $[\text{Fe}/\text{H}] \approx -0.7$; (vii) based on our elemental abundances we find that kinematical criteria produce thin and thick disk stellar samples that are biased in the sense that stars from the low-velocity tail of the thick disk are classified as thin disk stars, and stars from the high-velocity tail of the thin disk are classified as thick disk stars; (viii) age criteria appears to produce thin and thick disk stellar samples with less contamination. These points were recently discussed in Bensby & Feltzing (2011). Based on the current sample we have also found that the Hercules stream is likely to be of dynamical origin and that its stars just is a mix of thin and thick disk stars (Bensby et al. 2007a). In this proceeding we will discuss new findings about the variation of the elemental abundance ratios in the Galactic disk with Galactocentric distance.

2. Variation with Galactocentric radius

Fig. 1 shows the $[\text{Fe}/\text{Ti}]-[\text{Ti}/\text{H}]$ abundance plot for the full sample. The stars have been colour-coded based on their orbits mean distance from the Galactic centre (R_{mean}), as well as size-coded based on their estimated ages. A majority of the stars with $R_{\text{mean}} < 7$ kpc are α -enhanced and have high ages (i.e. red and big circles). The opposite is

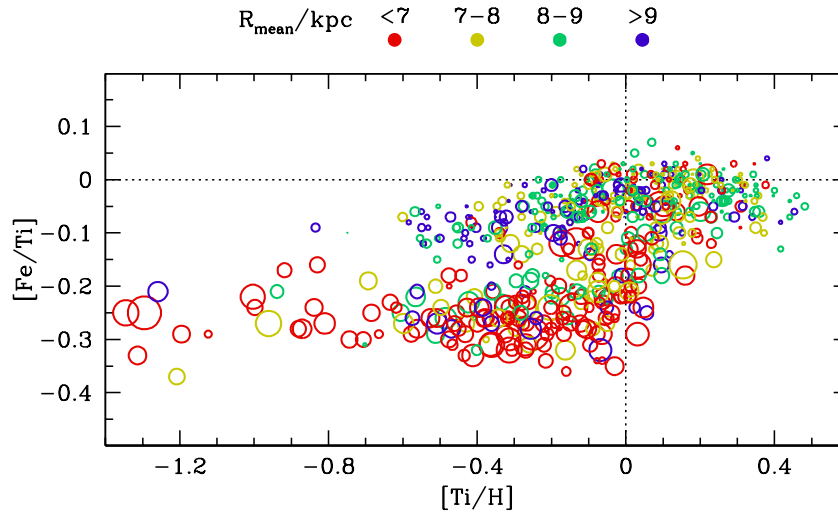


Figure 1. $[\text{Fe}/\text{Ti}]$ - $[\text{Ti}/\text{H}]$ abundance plot. The color-coding refers to the mean Galactocentric radius of the orbits of the stars and is defined at the top of the figure. The sizes of the circles have been scaled by the ages of the stars (larger = older).

observed for the stars with $R_{\text{mean}} > 9$ kpc which tend to be less α -enhanced and have lower ages (i.e. blue and small circles).

If R_{mean} can be associated with the approximate birthplace of a star, and if a main characteristic of the Galactic thick disk is that its stars mainly are old and α -enhanced, the above finding indicates that the thick disk stars in the solar neighbourhood, should mainly originate from the inner disk region. Younger and less α -enhanced (thin disk) stars on the other hand are more prone to originate from the outer disk region. This result agrees well with the study of red giants located in the inner and outer disk by Bensby et al. (2010, 2011) where it was found that the stars with thick disk abundance patterns appears extremely sparse in the outer disk, even at large distances from the Galactic plane. In the inner disk region on the other hand, both thin and thick disk abundance patterns were found. A possible explanation is that the scale-length for the thick disk is significantly shorter than for the thin disk (Bensby et al. 2011). What this means for the existence of an outer thick disk, and the dichotomy of the Galactic disk as seen in the solar neighbourhood, will be further investigated in an upcoming paper.

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References

- Bensby, T., Alves-Brito, A., Oey, M. S., Yong, D., & Meléndez, J. 2010, *A&A*, 516, L13
- 2011, *ApJ*, 735, L46
- Bensby, T., & Feltzing, S. 2011, arXiv:1110.0905v1 [astro.ph.GA]
- Bensby, T., Feltzing, S., & Lundström, I. 2003, *A&A*, 410, 527
- Bensby, T., Feltzing, S., Lundström, I., & Ilyin, I. 2005, *A&A*, 433, 185
- Bensby, T., Oey, M. S., Feltzing, S., & Gustafsson, B. 2007a, *ApJ*, 655, L89
- Bensby, T., Zenn, A. R., Oey, M. S., & Feltzing, S. 2007b, *ApJ*, 663, L13